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TEXAS IN ITS GEOGNOSTIC AND AGRICULTURAL ASPECT.

BY J. BOLL.

HAVING resided for several years in Texas, during which time I have constantly been engaged in scientific researches, I shall, in this article, aim not so much at a geological and geognostic description of the country, as attempt to present results already made known by others, and to give a slight view of my own observations in the same field. I shall not undertake a description of rocks and minerals heretofore found in Texas, nor enumerate animals already known as extinct or as still existing; but rather from the nature of the soil and the constitution of the mineral kingdom, draw my conclusions as to the fertility and products of the different parts of the State.

Of the various publications by other persons on the geologic and geognostic conditions of Texas, the following are known to me:

1. Texas, with special reference to German emigration and the physical condition of the country, as described after personal inspection by Dr. Ferdinand Roemer, together with a scientific addendum. Bonn, 1849.
2. The Chalk-formations of Texas, and their organic contents, by Dr. Ferdinand Roemer. Bonn, 1852.
3. Exploration of the Red river, in 1852, by Rand. B. Marcy, in which the northwestern part was geologically described, by Geo. B. Shumard.
4. The Annual Reports of State Geologist Buckley.
5. The Map of Texas, by A. R. Rössler. 1874.

The geographical character of Texas, as Roemer correctly remarks, divides it into three districts, more or less sharply defined. These are:

1. The Lowlands, along the whole coast, from the Sabine to the Rio Grande. They vary in width from thirty to a hundred miles, rising from three to a hundred feet above the sea, and are really only a continuation of the coast-lands of Lousiana, Mississippi and Alabama, and therefore belong to the same diluvial and alluvial formations, being almost wholly composed of clayey and sandy deposits. However, it is not alone the rivers coming from the interior which collect and bring down this material, for the sea also contributes its part. As proof of this, we find in the soil, not only the remains of marine animals, but the animal and vegetable world still extant gives evidence thereof. Here, not

only on the coast but in the whole region, we find those plants and insects living near salt-water only. The long narrow islands lying along the coast of Texas must necessarily, on account of their situation and physical condition, be considered as parts of the Lowlands.

2. The Hill country, or Uplands. This consists of the prevailing level and hilly region between the lower coast-range and the higher and partly rocky highlands beyond. Its width is from a hundred and fifty to three hundred miles, about one hundred to one thousand feet above the sea. According to its geological composition, it partakes in equal parts of the tertiary and secondary formations. The fertility of its soil is exclusively due to the composition of these formations, hence within it are embraced the fairest and most prolific portions of the State. Large, extensive prairies are situated in the west, with strips of timber along the creeks and rivers, also large and small forests diffused here and there, but composed wholly of post-oak. The eastern portion is almost entirely covered with forests of a great diversity of timber.

3. The Highlands. These arise behind the rolling hill-land, beginning in the west on the Rio Grande, where, at its confluence with the San Pedro, it suddenly turns its eastern into a southeastern course. Thence the boundary extends due east to the great sources of the San Antonio; thence north-east to Austin; and thence due north it reaches the Red river near the mouth of the Little Wichita.

From the Rio Grande to Austin, the boundary between the Hill country and the Highlands is well marked and sharp; while from the latter point to Red river the transition is more gradual and more difficult to define. The highest places in it rise scarcely 2500 feet above the sea, excepting the Guadalupe mountain, west of the Pecos river. In the north-west part of the State, towards New Mexico, the elevation slowly increases towards the Rocky mountains. No higher mountain chains are at all to be seen, and this region has rather the character of a high table-land. The inequalities arise more from the excavations of valleys and ravines, while the elevations generally maintain the same level. In its geological character it is greatly diversified, belonging, as it does, to the tertiary, secondary and primary formations. In very many places the soil is very dry, sterile and rocky, especially the valleys in the south, presenting steep and rocky entrances, rarely widening into fertile plains. All the principal rivers of Texas rise in this division, which is but sparsely settled and but imperfectly explored and known.

If now we take under review the formation and composition of the soil of these different parts of the State, the following will be the result as to their fertility and products:

In general we distinguish three different kind of soils—sand, clay and limestone—in the first, sand or silica predominates, in the second, clay, in the third, carbonate of lime. Neither of these constituents alone is sufficient to produce a vigorous growth of plants; that this is the case with sand is proved by the great deserts of Asia and Africa. When sand constitutes more than nine-tenths of the soil, vegetation cannot flourish; yet all soils require a certain proportion of sand, because every plant needs some sand for its growth; for cereals especially this element is indispensable. The clay soil has also its defect, it is too tenacious, so that the roots cannot spread out; it retains water too long, and when it dries it hardens into tough lumps; it has, therefore, precisely the opposite faults of sand, wherefore a proper intermixture of the two proves advantageous. A soil consisting solely of lime varies too violently in moisture and dryness; lime is, however, as indispensable for the nutriment of plants as sand, so that mixed in proper proportions with sand and clay, it proves itself highly advantageous in every respect; hence soils composed of sand, clay and lime are, without doubt, the most fertile.

Now, as regards Texas particularly, its sandy soil was mainly derived from the sandstone of the tertiary period, whilst its clay and lime soil deposits came from the tertiary and Mesozoic ages.

The soil of the Lowlands is, through the accumulation of sand, clay and lime, brought into a mixture very beneficial to cultivation, but owing to the presence of salt, and still more to its level surface, which hinders the discharge of water, it is not adapted to every kind of cultivation, wherefore wheat cannot be raised, whilst Indian corn, sugar-cane and cotton succeed admirably. The entire Lowlands are not yet extensively cultivated, and its more general culture depends upon a thorough system of drainage. The condition of the soil is everywhere the same, neither stones nor rocks are to be seen.

In the Hill-country we find the sandstone, and the sand and clay deposits of the tertiary formation in vast extent, and the peculiarity of it is that these places are, throughout, covered with forests, indeed we may safely conclude that wherever extensive forests are found in elevated positions, they arise from a tertiary foundation. Thus the whole forest-clad parts of Eastern Texas, from Red river down to the sea-coast, consist of these formations, the upper and lower cross timbers of North-western Texas, like the post-oak forests situated in the middle and southern, rest throughout upon tertiary formations. Since now the soil there, mainly through the influence of the glacial era, was derived from sandstone and sandy-clay deposits, it is, therefore, less adapted to the cultivation of plants, having obtained a large share at the same time through a considerable proportion of iron, as we shall see later; yet along creeks and rivers are found here and there places fit for cultivation. In the first years of culture, plants flourish generally quite well; but the strength of the soil is soon exhausted, which has strikingly exhibited itself in parts of Louisiana bordering on Texas, this side of Red river. This region has been for a long time thoroughly cultivated, and at this time has only two-thirds of its former extent under culture. Wheat does not succeed in this soil, and cotton is mostly only one to two feet high; corn is weak in the stalk and the ears are small; fruit-trees alone flourish there, viz: peaches and apples, since these trees are enabled to send their roots deep into the ground. Pines, which grow best in sandy regions, diffuse themselves to a great extent through the forests. Since then, by means of forests, we can decide the tertiary foundation of the soil, so in the same way we may state that open prairies and places covered with mesquite trees, indicate that the soil rests upon secondary formations. There again the soil is formed of sand, clay and lime, through the operation of the glacial era, and mingled together in so advantageous a manner that it presents all those conditions on which depends the perfect development of all cultivated plants. This division embraces that part of Texas which promises to become so large a source of food such as no other State of the Union possesses, even such as can be found in few portions of any continent. Again, in this same division is that region of peculiar importance in which naked rocks appear on the surface, neither to a small nor great extent immediately after the tillable ground has been broken up by other causes.

Such a wholly continuous area, more than one hundred and twenty miles wide, and over two hundred miles long, lies in the northern part of the Hill-country of Texas. It forms a long rectangle, of which Dallas county is nearly the center, and this is the reason why this division, and especially the city of Dallas, have so rapidly grown in importance, and this proves at the same time with what keen foresight railroad magnates have stretched their iron roads through this section.

This division is, however, penetrated in its north-western part by the so-called Cross Timbers, two strips of forests from eight to ten miles wide, the soil of which consists of the tertiary elements, but their intermixture through the physical influences of the glacial period, since the extent was not very great, became much superior to that in Eastern Texas. Besides, it constitutes only a very small part of the division under consideration, and supplies at the same time, to the adjacent prairies, convenient and adequate material for fencing and fuel, which only in few places has to be procured from considerable distances.

In the southern and south-western portion of the Hill-country, as far as the Rio Grande, the soil is also composed of sand, clay and lime, yet, as in the northern part, it is more frequently interrupted by tertiary clay and sand, but much more, and more injuriously to agriculture, is the ground filled with hard, reddish flint stones, from the size of a pigeon-egg to that of the fist. These originate in the Highlands north of it, on one side of the primitive mountains arising there, and still more from the extensive chalk hills. This chalk formation of the Highlands is of a sandy character, hard, and enclosing a great number of sand and flint concretions. After the drift period they remained scattered in every direction, and this readily explains why these concretions are found not only in river beds but also on those higher localities surrounding the valleys, and particularly on hills. The soil of this part of the Hill-country is here and there so filled with these stones that it is useless to undertake a thorough culture of it. Although these places often interrupt the fertile soil, yet the latter comprises a considerable area, and it is especially the river-bottoms which in the southern part of the Hill-country possess an immense productive power. In the valley of the San Antonio river, almost the entire bottom of the valley can be irrigated for a great distance, yet this system of irrigation, constructed by the

Spaniards many centuries ago, has already so exhausted the soil of loose, light mineral material, that a rich crop can no longer be reckoned upon excepting here and there.

In this connection the following points may be mentioned. Till now it has always been a problem where the great sources of the San Antonio river, as also of the Comal and San Marcos, have their origin, and why these throughout the whole year continue to break forth from under the rocks with the same force and temperature as well as with unvarying clearness.

Roemer, in his work on the chalk formations of Texas, says, that the chalk of the Highlands is proven by its organic remains to belong to a somewhat deeper geognostic horizon than that of the Hill-country, and is therefore older, although it lies higher. It is suddenly separated, steep and sharp, from the latter. He says, furthermore, it is possible that through a fault not apparent on the surface, the chalk of the Highlands near New Braunfels was forced back to the higher level, and he believes that such transposition and also the sudden and steep upheaval of the Highland, explains the remarkable change in the character of the rocks, and that the abrupt breaking forth of the sources of the Comal at the foot of the table-land has a close connection with it.

Northward and located somewhat higher there appears in a singular manner, almost wholly surrounded by the chalk formation of the Highlands, an entirely isolated tract of primitive mountain formation, and it is well to observe that this piece was lifted up through terrestrial forces after the chalk formations had already detached themselves. On this granite are found here and there isolated remains of chalk. Before the glacial era the entire mass was entirely covered with it, and it was almost completely destroyed during this long period, and I might therein discover not only a proof of its later upheaval, but also of the existence of the glacial era; so also other and not yet solved problems may here find a solution. Through the upheaval, the volcanic force extended also to the chalk surrounding the granite.

As already remarked, the chalk of the Highlands is much harder than that of the Hill-country; as a collective mass it resisted the upheaval, and was therefore lifted up at once with the granite: hence the steep declivity at the foot. By the upheaval considerable cavities would be formed in and under the chalk, for it is everywhere much cleft, and the rain falling on the ground finds its way slowly, therefore, partly through the rocks, into the cavities. It can accumulate in large quantities in these hollows; the water must necessarily find an outlet again, and thus it is probable that the above-named rivers come from one or more subterranean lakes, and hence their uniform force, temperature and clearness. The water of these springs holds a great deal of carbonate of lime in solution, which shows that in the course of time the cavities are more and more enlarged; this view opposes at the same time the opinion that the water takes its origin in the Staked Plains of North-western Texas; if this were the case they must contain not only the carbonate but also the sulphate of lime in considerable quantities, since gypsum is extensively diffused there.

Passing now to the Highlands, which embrace the whole remaining part of Texas; it is the largest but the least satisfactorily known. The tertiary formation is very little diffused, and hence the soil is mainly derived from primary and secondary deposits. Nowhere are found extensive tillable and continuous tracts as in the Hill-country; the good planting-ground is mostly confined to the river-bottoms and valleys; only in particular counties are larger tracts of tillable land to be obtained. As already remarked, this high table-land is mostly rocky, dry, and sterile; but owing to good meadow-grounds, it is particularly well adapted to cattle-raising, which therefore is followed in a very extensive manner.

These Highlands have, however, for Texas a particular importance in other respects; it is mainly there that mining will, in future, be prosecuted.

As regards the evidences of mineral wealth, we need not, for known reasons, look for them in the surface of the Lowlands. The whole of the Hill-country encourages no hope of rich mineral treasures. Throughout this entire division, however, coal has been discovered in many places; but, according to all scientific principles and personal observations, I must declare that there has been found no coal belonging to the genuine coal-formation; but only such of the tertiary and secondary periods—the so-called lignite or brown coal. It is, also, nowhere found in extensive and vast deposits, rarely easy to work; although that of the secondary division, as approaching nearer in age to genuine stone-coal, possesses in a considerable degree the elements of fuel. In many parts of the undulating Hill-country are found masses of petrified wood. As Roemer already correctly concluded, this belongs to the tertiary formation; and we can, therefore, by this means decide with certainty upon its presence there. The immense proportion of silex in this formation has petrified the wood, instead of carbonizing it.

On the bank-slopes of the Red river, near Shreveport, I found a layer one to two feet thick, which was half carbonized, and half petrified; and in the same stratum lay large logs of cypress in a half carbonized and half petrified state.

The large deposits of iron-ore in the tertiary formation of Eastern Texas may become of somewhat more importance than the coal in the Hill-country, but they by no means equal in value the ore-deposits of older origin. The iron is here found mainly as iron sandstone, and in many counties, as in Henderson, Anderson, etc., in such quantities that whole ranges of hills are formed of it; and the region presents many times, by their rocks and the ravines between, a quite romantic character; this is particularly the case with the so-called big rocks between Vanzandt and Henderson counties. The tertiary formation is also rich in salt deposits, and in many places the salt is successfully obtained from salt-springs. In the iron regions we encounter in some places very strong mineral springs, especially sulphur-springs. They hold in combination much carburetted hydrogen gas and sulphuret of iron; when they come to the surface, they liberate blackish gray and yellowish precipitates of sulphur and sulphuret of iron; but they do not come from any considerable depth like thermal springs, since they have nearly as low a temperature as the ordinary springs of the neighborhood. On the Neches river, as well as on the Sabine, I found larger deposits of a blackish-iron sandstone, which was quite loose and brittle; it holds iron mostly as sulphuret of iron. Owing to its slight coherency, the latter may, through several influences, be easily decomposed, and then on the one side give cause to the sulphur springs, and on the other to the sulphate of iron produced in that region. There are also many beds of clay, which contain alum, or bittersalt, and impart for this reason a strong taste to water; in particular places, in summer, there is seen in the bottom of tumblers, after the evaporation of the water, a white crust of this salt. Of greater importance to mining in Texas are the Highlands.

From the mouth of the Little Wichita into the Red river down to the Colorado river, where the Pecan bayou empties into the same, there lies, towards the west, a region about one hundred miles wide, that belongs to a much older mountain formation, the so-called coal or transition mountain. In this is found in abundance the copper-schist or the Permian system, as also the Silurian. Shumard looked already upon this region as belonging to the coal-formation; and the organic remains which exist in the rocks speak most plainly; such are trilobites, fossil fishes of the families of Ganoids and sharks, and the imprints of the ferns with Equisetaceous and other plants. I have found also in this formation various Mollusca, chiefly *Brachiopoda* and *Lamellibranchiata*, wholly petrified in the iron-ore, called sphærosiderite. We find now and then, on the surface of this coal-formation, copper-ore, consisting mainly of malachite, which originally penetrated in veins through sandstone; it is often several inches thick. There are also found immense masses of iron-ore in very many different conditions, lying around loose on the slopes, in ravines, and everywhere; and especially those that appear most numerous, are the hematite and ironspar or sphærosiderite; and which, it seems, have been taken by some persons for copper; yet I have no doubt but that considerable copper and other ore deposits may still lie hidden in some deeper stratum. The different iron-ores contain, according to my analysis, twenty to seventy per cent. pure iron, and among them many spars, a little zinc, and traces of cadmium. If we compare these ores with those of other countries, it is apparent that they are among the best, and most easily reduced; they are the same ores out of which nearly nine-tenths of all the iron in England is produced.

From these geological and palæontological facts, we are permitted with all certainty to conclude that, although hitherto no positive data have existed, there must be throughout this whole division large, extensive, and genuine coal-beds. In the geological State museum at Austin can be seen large pieces of genuine stone-coal, but without any precise information as to the place of discovery.

Bismuth and antimony, it is claimed, have already also been found. Some time ago the newspapers gave information that a very rich silver mine had been discovered in Montague county; but it may well be doubted whether this news is correct, and it may have been published from interested motives. Gold, silver, lead, and molybdenum are, however, found in the previously mentioned primitive mountain formation of the Highlands, where in later times, in Llano county, a silver mine is said to have been put in operation. Westward of the coal-formation, particularly along Red river and in the Staked Plains, lie very large beds of gypsum; but the future must reveal to us how large treasures in metals lie in the still unknown regions of the west.

If we cast a retrospective look over the whole, we may assert with all certainty that Texas is approaching a very promising future. It is a country in which, on account of its fine and favorable position, not only all the plants of the temperate zone flourish, but also many of those of the tropics. The wine-culture, to which many a State owes its prosperity, is yet in the germ; but the results attained on a small scale hitherto, the great number of excellent wild grapes, as also the above-described constitution and combination of the soil,—are all speaking evidences of its adaptation to this noble fruit.

Texas has its own pine-forests in the east, which will be fully adequate to supply the whole State with lumber, and to fence in the fields; in the interior it has its own granary; and when once her own hand has wrought her own iron with her own coal, then will she supply not only her own wants, but many of those of the outer world.

Nowhere are there extensive swamps which makes residence unhealthy; the country has also no sections which suffer from excessive drouth. Winters have neither the northern cold, nor the summers the tropical heat; and pleasant breezes throughout the whole summer keep the air continually, not only in a refreshing condition, but contribute much to the salubrity of the country. Though we may not have to point out lofty, romantic mountains, still there are regions highly favored by nature, particularly those about San Antonio and New Braunfels, with their mighty springs, and their ever clear and refreshing water, that are especially noteworthy; which places, if they were lying on the sea, would justly be called the Texan Nice.